

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 08 MAR 2006

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Applicant's or agent's file reference F18523 AS/vd	FOR FURTHER ACTION		See Form PCT/IPEA/416
International application No. PCT/IB2004/003840	International filing date (day/month/year) 24.11.2004	Priority date (day/month/year) 26.11.2003	
International Patent Classification (IPC) or national classification and IPC B22D17/00, B22D17/20, B22D17/30, B22D17/02, B22D17/04			
Applicant RAFFLE, Marie Thomas Gilles			

<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <ul style="list-style-type: none"> a. <input checked="" type="checkbox"/> <i>(sent to the applicant and to the International Bureau) a total of 13 sheets, as follows:</i> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions). <input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box. b. <input type="checkbox"/> <i>(sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</i>
<p>4. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Box No. I Basis of the opinion <input type="checkbox"/> Box No. II Priority <input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability <input type="checkbox"/> Box No. IV Lack of unity of invention <input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement <input type="checkbox"/> Box No. VI Certain documents cited <input type="checkbox"/> Box No. VII Certain defects in the international application <input type="checkbox"/> Box No. VIII Certain observations on the international application

Date of submission of the demand 23.06.2005	Date of completion of this report 07.03.2006
Name and mailing address of the International preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Bergman, L Telephone No. +49 89 2399-8443

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/003840

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
 - international search (under Rules 12.3 and 23.1(b))
 - publication of the international application (under Rule 12.4)
 - international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

Description, Pages

2, 3, 8-12, 14-23 as originally filed
1, 1a, 4, 5, 5a, 6, 7, 13 received on 25.07.2005 with letter of 22.07.2005

Claims, Numbers

1-16 received on 25.07.2005 with letter of 22.07.2005

Drawings, Sheets

1/5-5/5 as originally filed

a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. The amendments have resulted in the cancellation of:
 - the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
 - any table(s) related to sequence listing (*specify*):
4. This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - the description, pages
 - the claims, Nos.
 - the drawings, sheets/figs
 - the sequence listing (*specify*):
 - any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/IB2004/003840

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-16
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-16
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. Prior art

- D1: US-A-4 347 889 (KOMATSU ET AL) 7 September 1982 (1982-09-07)
- D2: US-A-4 842 038 (FUJINO ET AL) 27 June 1989 (1989-06-27)
- D3: US-A-6 068 043 (CLARK ET AL) 30 May 2000 (2000-05-30)
- D4: EP-A-0 662 361 (HITACHI METALS, LTD) 12 July 1995 (1995-07-12)
- D5: EP-A-0 710 515 (REYNOLDS WHEELS INTERNATIONAL LTD) 8 May 1996 (1996-05-08)

2. Disclosure of the most relevant prior art

- 2.1 D1 discloses a pressure die casting machine with vertical axis wherein a melting chamber heated by an induction coil. Two die halves form a die cavity, located above a vertical injection cylinder (8) mounted on the top end of a coaxial melting chamber (9) containing an injector piston driven upwards via a work cylinder. Both cylinders (8, 9) have the same bore diameter, and cylinder (9) is surrounded by a heater, especially a high-frequency(h.f.) induction coil employed to melt a billet placed in cylinder(9). The cylinder(9) is mounted on a mobile plate which is lowered for loading the billet into the cylinder(9). Pulse motors (13) are used for the vertical movement of the plate, cf. abstract, claim 1. Further details are obvious from the drawings.
- 2.2 D2 discloses an injection method and apparatus for die casting metals, the method comprises producing billets of the size required for an individual casting, preheating the billet in order to melt its central core without melting the sides and bottom, transferring to an injection case and melting all the billet followed by injecting the metal into a mould. Two die halves form a die cavity, located above a stationary sleeve (10) positioned above a coaxial melting chamber in form of a cylindrical injection sleeve (22) containing plunger (23) connected to an hydraulically activated injection cylinder (19). The cylinder (22) is mounted on a rotating table (16) which is pivoted for loading the billet into the cylinder (22). Sleeve tables connected to the

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(SEPARATE SHEET)**

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piston rod (26) of a shift cylinder (25) are used for the vertical movement of the injection sleeve (22), cf. abstract, Fig. 1.

3. Novelty and inventive step

None of the cited documents discloses the provision or use of a telescopic piston arrangement including a central piston and a peripheral piston surrounding the central piston as defined in claims 1 and 10, respectively. Novelty is therefore given.

The subject matter of claims 1 and 10, respectively, is distinguished therefore in the provision and use of a telescopic piston arrangement including a central piston for acting on the charge within the sleeve said piston being surrounded by a peripheral piston used for moving the sleeve. In the cited prior art there is not found any hint towards a telescopic piston arrangement or the provision of a central and peripheral piston. Accordingly, the claimed piston arrangement is not rendered obvious by the cited art for any reason and plausible allows easy removal and/or replacement of the sleeve after each shot. An inventive step is therefore acknowledged.

CASTING OF METAL ARTEFACTS

THIS INVENTION relates to the casting of a metal artefact. More particularly, the invention relates to a process for casting a metal artefact and to a casting apparatus or installation for casting a metal artefact, the process and apparatus or installation being particularly suitable for casting light metal artefacts. As used herein, the term light metal encompasses both light metals as such, and alloys thereof in which light metals form the major proportion of over 50% by mass thereof, light metals being those having a density of less than 2.7 g/cm³. Light metals usually have low melting points of 660°C or less.

According to a first aspect of the invention, there is provided a process for casting a metal artefact, by forming a molten charge of metal from a precursor thereof, charging a die or mould with the molten charge to fill the die or mould sufficiently to form a single metal artefact and causing or allowing the charge to solidify in the die or mould to form the artefact, the process including the step of selecting the size of the molten charge to match the capacity of the die or mould so that the charging of the die or mould consumes substantially the whole molten charge, the charging of the die or mould being from a hollow cylinder or sleeve by means of a telescopic piston arrangement which elevates the cylinder or sleeve into engagement with the die or mould and into communication with a charging opening into the die or mould; and a central piston of the piston arrangement entering the cylinder or sleeve and slides upwardly therein in sealing engagement therewith during the charging, while a peripheral piston of the piston arrangement, surrounding

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the central piston, urges the cylinder or sleeve upwardly into sealing engagement with the die or mould around the charging opening of the die or mould.

5 Although the process may include the step of forming the molten charge from a precursor thereof which is a mixture of one or more ores, fluxes, alloying elements and the like, the molten charge is preferably formed from a

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The process is expected to be useful, in particular, in the casting of light metal or light metal alloy products selected from the group consisting of wheel rims, such as aluminium- or magnesium-alloy wheel rims, automotive gearbox casings, 5 steering wheel housings, brake auxiliary parts or components, and automotive engine, marine and aircraft parts or components. Typically, the process will be used in the casting of aluminium- and magnesium-alloy wheel rims, so that the casting may be of a light metal artefact in the form of motor vehicle wheel rim.

10 The process is expected to be useful in casting artefacts having cross-sectional thicknesses in the range 1.5 – 30mm, usually 2 – 27mm, with respective masses of 0.25 -30kg, usually 0.5 – 20kg. Thus, in particular, the casting may be of a metal artefact in which the part of the solidified artefact which is furthest from the surface of the artefact is spaced from the closest part of the surface of the artefact by 15 a spacing of 0.75 – 15mm, the artefact having a mass of 0.25 – 30 kg.

The process may be used with any type of die or mould, for example, a disposable die or mould such as a sand die or mould, or a re-useable die or mould such as a metal die or mould. In particular, the process in accordance with the present 20 invention is particularly suited for use with a metal die or mould forming a re-useable die or mould. Preferably, the metal die or mould is a steel die or mould.

The process may include forming the molten charge by induction heating of the precursor, the induction heating being such as to provide the molten charge with a 25 temperature profile, for example to ensure that the part of the molten
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charge which first enters the die or mould is hotter than that which enters the die or mould later. However, any desired profile can in principle be achieved.

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According to another aspect of the invention there is provided a casting apparatus or installation for casting a metal artefact in a die or mould, the casting apparatus or installation including a die or mould and a melting apparatus which includes a container for holding a precursor of a molten charge of metal, a heating arrangement for heating the precursor in the container to form a molten charge of metal, and a molten metal transfer assembly for transferring a molten charge of metal from the container to the die or mould, the container and die or mould having capacities which are matched so that charging of the die or mould from the container to fill the die or mould with a charge sufficient to form a single metal artefact consumes substantially the whole charge of molten metal from the container and leaves the container empty, the container being a hollow cylinder or sleeve, the molten metal transfer assembly being, a telescopic piston arrangement for elevating the cylinder or sleeve into engagement with the die our mould and into communication with a charging opening into the die or mould; and the piston arrangement having a central piston for entering the cylinder or sleeve and for sliding upwardly therein in sealing engagement therewith, the piston arrangement having a peripheral piston surrounding the central piston for urging the cylinder or sleeve upwardly into sealing engagement with the die or mould around the charging opening of the die our mould.

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The heating arrangement may be mounted on the molten metal transfer assembly. The melting apparatus may be reciprocable relative to the die or mould between a charging position where charging of the melting apparatus takes place and a filling position where transfer of a molten charge from the melting apparatus to the die or mould takes place.

The apparatus or installation may include an inert gas supply for supplying inert gas to the container, to permit forming of the molten charge to take place under an inert atmosphere.

The container may have a hollow cylindrical interior, for example being in the form of a hollow cylinder or sleeve. The container may be re-usable. Instead and preferably, the container is disposable, being for single use and being discarded thereafter. In the case where the container is disposable, it will be appreciated that cross-contamination from one metal or alloy charge to another is reduced, particularly in cases where the apparatus or installation is used successively to cast artefacts comprising different metals or alloys.

More particularly, the transfer assembly may comprise a telescopic multi-stage piston arrangement for use in elevating the container to engage lockingly with a die or mould prior to filling the die or mould with a molten charge from the container. In a particular embodiment of the invention, in which the transfer assembly comprises said telescopic multi-stage piston arrangement, the container is a said hollow cylinder, the cylinder being supported on the transfer assembly with its hollow interior in a more or less upright attitude, such that a central piston of the multi-stage arrangement is upwardly moveable within the interior of the cylinder in sliding and more or less sealing engagement therewith so as to enable a molten charge in the cylinder to be pushed upwardly and out of the cylinder upon the upward movement of the central piston, to transfer the molten charge to a die or mould, a peripheral piston, surrounding the central piston, being upwardly moveable to urge the cylinder upwardly to cause its upper end to seat sealingly against a lower surface of the die or mould, around a charging opening into the die or mould.

In particular, the central piston may have a piston head provided with a sealing surface for sealingly engaging the periphery of the charging opening of the die or mould, preferably when all the molten charge in the cylinder has been transferred from the cylinder into the die or mould. Thus, in use, the step of causing or allowing the molten charge to solidify in the die or mould to form the artefact will typically take place while the piston head sealingly engages the periphery of the opening.

The casting apparatus or installation may be of essentially immovable construction, being constructed *in situ*, at a production facility for casting light metal artefacts, in which case it can be regarded as an installation. Instead, and usually, the casting apparatus or installation is expected not to be of immovable construction, being moveable from one said production facility to another, in which case it can be regarded as an apparatus.

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The melting apparatus may be provided with wheels for running on rails forming part of the casting apparatus or installation, the wheels being for permitting reciprocating movement of the melting apparatus between the charging position where charging of the container with a precursor of a molten charge in use takes place, and a filling position where the melting apparatus is in alignment with the charging opening

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14 to a die or mould (not shown in Figure 1, but see Figures 3 to 5) in which an artefact is cast.

5 The melting apparatus 10 also includes an inert gas supply 22 for supplying argon gas to the interior of the cylinder or sleeve 14 such that melting of the light metal charge takes place under a substantially inert atmosphere, and also to provide cooling to the lower end or base of the cylinder or sleeve 14 to form a secondary seal therefor as described hereunder.

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The cylinder or sleeve 14 is re-useable. The cylinder or sleeve 14 is made of mild- or low carbon steel. In other embodiments, the cylinder or sleeve 14 is optionally made of cast iron or stainless steel.

15 In use, the induction coil 18 is mounted on the metal transfer assembly 20, the coil 18 being connected to the barrel 62 and surrounding the cylinder or sleeve 14 to heat the contents thereof.

20 The transfer assembly 20 comprises a telescopically moveable multi-stage piston arrangement 24 for use in elevating the cylinder or sleeve 14 to engage lockingly with the periphery of a downwardly facing charging opening of a die or mould, prior to filling the die or mould with a molten charge from the cylinder or sleeve 14. The multi-stage piston arrangement 24 incorporates a central piston comprising three telescopic piston rods 26, 27, 28 with the central rod 28 having a piston head 30 provided with a conical sealing surface 31 for sealingly engaging the periphery of

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CLAIMS:

1. A process for casting a metal artefact by forming a molten charge of metal from a precursor thereof, charging a die or mould with the molten charge to fill the die or mould sufficiently to form a single metal artefact and causing or allowing the charge to solidify in the die or mould to form the artefact, the including the step of selecting the size of the molten charge to match the capacity of the die or mould so that the charging of the die or mould consumes substantially the whole molten charge.

the process being characterized in that, in combination,

the charging of the die or mould is from a hollow cylinder or sleeve by means of a telescopic piston arrangement which elevates the cylinder or sleeve into engagement with the die or mould and into communication with a charging opening into the die or mould; and

a central piston of the piston arrangement enters the cylinder or sleeve and slides upwardly therein in sealing engagement therewith during the charging, while a peripheral piston of the piston arrangement, surrounding the central piston, urges the cylinder or sleeve upwardly into sealing engagement with the die or mould around the charging opening of the die or mould.

2. A process as claimed in Claim 1, characterized in that forming the molten charge is from a precursor thereof which is a metal billet or ingot or a compact of metal particles.

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3. A process as claimed in Claim 1 or Claim 2, characterized in that it includes heating the metal of the molten charge, after forming the molten charge, to raise the temperature of the molten charge, prior to filling the die or mould with the molten
5 charge at the raised temperature.

4. ~~A process as claimed in any one of Claims 1 - 3 inclusive, characterized in that the charging is carried out by injection moulding at an intermediate pressure in the range 50 KPa - 30MPa.~~

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5. A process as claimed in any one of the preceding claims, characterized in that it includes the step of purging the environment in which the molten charge is formed with a purging gas, prior to and during the forming of the molten charge.

15 6. A process as claimed in any one of the preceding claims, characterized in that it includes using, as the metal, a metal selected from the group consisting of aluminium, magnesium, lithium, zinc and alloys thereof.

7. A process as claimed in Claim 6, characterized in that it includes using, as the
20 metal, a light metal selected from the group consisting of magnesium, aluminium and alloys thereof.

2. A process as claimed in Claim 7, characterized in that the casting is of a light metal artefact in the form of a motor vehicle wheel rim.

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9. A process as claimed in any one of the preceding claims, characterized in that the casting is of a metal artefact in which the part of the solidified artefact which is furthest from the surface of the artefact is spaced from the closest part of the surface 5 of the artefact by a spacing of 0.75 – 15mm, the artefact having a mass of 0.25 – 30kg.

10. A casting apparatus or installation (50) for casting a metal artefact in a die or mould, the casting apparatus or installation (50) including a die or mould (54) and a 10 melting apparatus (10) which includes a container (12) for holding a precursor of a molten charge of metal, a heating arrangement (16) for heating the precursor in the container (12) to form a molten charge of metal, and a molten metal transfer assembly (20) for transferring a molten charge of metal from the container (12) to the die or mould (54), [the casting apparatus or installation being characterized in that] 15 the container (12) and the die or mould (54) having [have] capacities which are matched to be of equal volume so that charging of the die or mould (54) from the container (12) to fill the die or mould (54) with a charge sufficient to form a single metal artefact consumes substantially the whole charge of molten metal from the container (12) and leaves the container (12) empty,

20 the apparatus or installation being characterized in that, in combination, the container (12) is a hollow cylinder or sleeve (14), the molten metal transfer assembly (20) being, a telescopic piston arrangement (24) for elevating the cylinder or sleeve (14) into engagement with the die our mould (54) and into communication with a charging opening (62) into the die or mould (54); and

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the piston arrangement (24) has a central piston (28,30) for entering the cylinder or sleeve (14) and for sliding upwardly therein in sealing engagement therewith, the piston arrangement (24) having a peripheral piston (37) surrounding
5 the central piston (28,30) for urging the cylinder or sleeve (14) upwardly into sealing engagement with the die or mould (54) around the charging opening (62) of the die or mould (54).

11. An apparatus or installation as claimed in Claim 10, characterized in that the
10 heating arrangement is mounted on the molten metal transfer assembly.

12. An apparatus or installation as claimed in Claim 10 or Claim 11, characterized in that the melting apparatus is reciprocable relative to the die or mould between a charging position where charging of the melting apparatus takes place and a filling
15 position where transfer of a molten charge from the melting apparatus to the die or mould takes place.

13. An apparatus or installation as claimed in any one of Claims 10 -12 inclusive, characterized in that it includes an inert gas supply (22) for supplying inert gas to the
20 container, to permit forming of the molten charge to take place under an inert atmosphere.

14. An apparatus or installation as claimed in any one of Claims 10 -13 inclusive, characterized in that the container has a hollow cylindrical interior.

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15. An apparatus or installation as claimed in Claim 10, characterized in that the central piston has a piston head (30) provided with a sealing surface (31) for sealingly engaging the periphery of the charging opening of the die or mould.

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16. An apparatus or installation as claimed in any one of Claims 10 – 15 inclusive, characterized in that the heating arrangement includes at least one induction coil surrounding the container.

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